EGU21-9763
https://doi.org/10.5194/egusphere-egu21-9763
EGU General Assembly 2021

Dynamical analysis of extreme tropopause folding events in the coastal region of Antarctica

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Rapid and deep descent in the tropopause (the so-called tropopause folding; TF) is often observed in the extratropics. Previous studies pointed out that the frequency of deep TF is maximized along the coast of Antarctica. However, the dynamics of TF in the Antarctic region have not yet been studied adequately. In the present study, the extreme TF in the Antarctic are examined using the state-of-art reanalysis data to clarify the uniqueness of TF in the Antarctic.

First, the distribution of TF frequency in the extra-tropics of the Southern hemisphere is examined. In austral winter, extreme TF often occurs along the coast of Antarctica. Around Syowa Station (69.0S, 39.6E), the frequency of extreme TF is maximized in August while the frequency is small in austral summer. It is interesting that the coast of Antarctica is located to the south of the maximum of the synoptic-scale eddy kinetic energy. This implies that the maximum of TF frequency along the coast of Antarctica cannot be explained only by the geographical distribution of the storm track.

Next, to examine the dynamics of the extreme TF events along the coast of Antarctica, we perform composite analyses of the extreme TF events at Syowa Station. When the negative anomaly of tropopause height is maximized, the significant downwelling is observed at the location of the extreme TF. From the analyses using the quasi-geostrophic Q-vector, it is found that the divergence of the Q-vector is observed around Syowa Station. The distribution of Q-vector is explained by the local westerly jet and strengthening of the frontal structure associated with a synoptic low-pressure system extending west-east centered at 70°S over Antarctica. The mechanism of the low-pressure system extending along the coast of Antarctica based on ray-tracing theory under the WKB approximation is also discussed.